DESIGN AND ANALYSIS OF E SHAPED MEANDER ANTENNA FOR C-BAND APPLICATION

Sherly Arunodhayamary P

Department of Electronics and Communication Engineering,
MEPCO Schlenk Engineeering College,
Tamil Nadu, India.
sherlyarunodhayamary@gmail.com

ABSTRACT

In this paper, the performance of meander line antenna with microstrip feeding technique for C-Band application is designed and analyzed. Meander antenna are mostly used in application to satisfy the requirement of small working space. This E-shaped meander antenna covers c-band applications such as cordless telephones, weather radar systems and Wi-Fi devices. The antenna performance is analyzed with two types of materials FR-4 EPOXY and RT-DUROID substrate of thickness 1.6mm. In addition to these cases, two grounding conditions are also focused, one is partial ground and another is full ground condition. Meander antenna is designed with dimension of 20mm x 11mm x 1.6mm. The Ansoft HFSS 3D EM simulator is employed for design simulation. The proposed antenna has big potential to be implemented for Satellite communication application.

Keywords: Meander antenna, FR-4 Epoxy substrate, RT-Duroid, Partial ground, wireless application.

INTRODUCTION

In recent years, the rapid advances in wireless communications applications lead engineers to focus on various research aspects. Among the growth in many direction, microstrip antenna has a good spot due to their light weight, small in size. Wireless communication includes forms of communication between two or more devices using wireless signal which is basically a radio wave.

Wireless communication is always a field of revolution, adapts to exceeding level of smartness day by day. wireless devices, such as cellular telephones and radio transceivers, can be used for Internet access, including e-mail, the World Wide Web, newsgroups, and instant messaging. Mender line antenna is a type of microstrip antenna that allows designing of antenna with a small size and provides wideband performance. This is an interesting class of resonant antennas and they have been widely studied in order to reduce the size of the radiating elements in wire antennas: monopole, dipole and folded dipole type antennas [1]. Meander line constitutes a class of MPA with its horizontal and vertical lines to give small size and wideband performance antenna for numerous applications [2]. Meander line antenna has application in the USB technology. A major limitation of the USB technology is the presence of the cables. With the high-speed USB-WLAN card, devices can be connected to the PC without cables. The antenna design for USB-WLAN card will be a challenging task due to the space constraint as well as the need to maintain good impedance and radiation performance across a broad operating bandwidth. The meander shape has been tuned to resonate at desired frequency band with FR-4 substrate and input of VSWR in the range of 2.4 to 2.5 GHZ. Meander line antenna are also suitable for integration with the Printed Circuit Board (PCB) on a universal serial bus (USB)-WLAN [3].

Other than microstrip feeding technique, coaxial probe method is also used in contact feeding technique. Increase in thickness of dielectric substrate results in bandwidth increase. Linear as well as circular polarization can be achieved by controlling the input currents. Increase in total wire length by continuously folding is to reduce the resonant frequency. This idea results in decrease in size but the radiation resistance, efficiency and bandwidth decrease. Small size of the antenna enables itself to be introduced in complex systems and can be used for various applications including GSM1800/1900,WCDMA2100 and LTE1800/2300/3700 TDD for mobile handsets and mobile assisted health applications [4]. The number of turns, feed width, transmission line length and partial ground length have influence in attaining the optimum value of the return loss less than -10dB and Gain. Here 2.45 GHZ MLA is capable to function at wide bandwidth of 0.22 GHZ but unwanted loss happens due to fabrication and results in 0.18 GHZ [5].

Till today several research works has introduced several types of microstrip antennas and investigations have resulted in observed disadvantages such as narrow frequency bandwidth, and low efficiency.

PROBLEM STATEMENT

Past works depicts the idea of various design structure of the meander antenna. Optimization of design, results in decreased bandwidth and efficiency. Most of the Meander antenna design focus on achieving ISM band frequency and S band frequency application.

- Achieving a higher bandwidth in minimized MLA due to the folded structure is always a drawback.
- Reduction in size aids in the promotion of MLA in handheld devices. But, reduction of size results in decreased efficiency.

DESIGN:

The geometry of the front view of the meander antenna is illustrated in Fig. 1. The geometry is provided with microstrip feed line technique. In Fig.2, the design shows the case of partial ground condition. In the back view Fig. 3, thefull ground condition is shown. The ground is placed at the back of the MLA. Here, two types of substrate are considered,FR-4 Epoxy, RT- Duroid.The FR-4 dielectric substrate has relative permittivity of 4.4, substrate thickness of 1.6mm. Another one consideration is, RT-Duroid dielectric substrate with relative permittivity of 2.2, substrate thickness of 1.6mm. In this design, the ground functioned as a tuning circuit of the antenna's impedance matching. So, the MLA with partial ground is considered and also the full ground case is taken into consideration. Partial ground condition shown in Fig. 2. has dimension of 10mmx11mmx1.6mm. Full ground condition shown in Fig. 3 has dimension of 20mmx11mmx1.6mm.

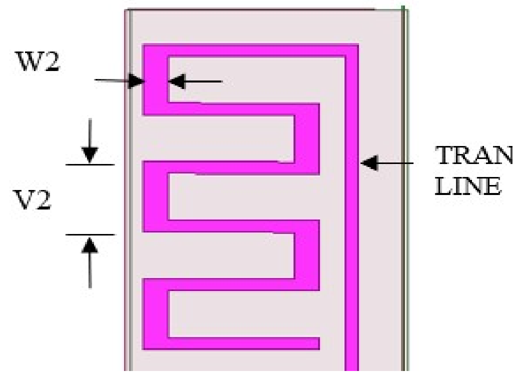

Fig.1. Design (Front View)
Common to both partial and full ground condition

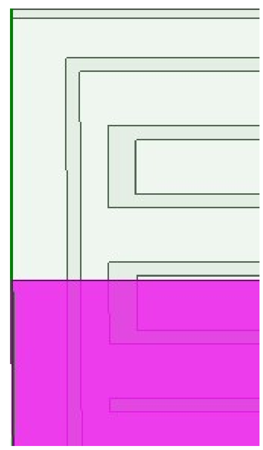

Fig. 2. Design (Back View)
Partial ground condition

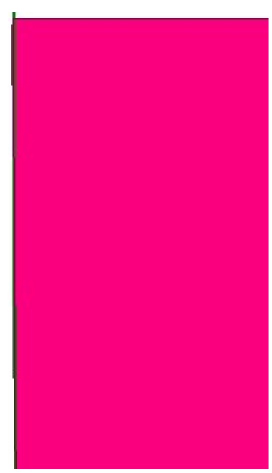

Fig. 3. Design (Back View)
Full ground condition

Table.1. Specification of antenna design

TYPE	DIMENSION (mm)
Length x width of the substrate	20 x 11
Length x width of the ground	20 x 11
Length x width of the partial ground	10 x 11
Thickness of the substrate	1.6
Width of the transmission line (w1)	0.5
Vertical width of the turn(w2)	1.5
Vertical length of the turn(v2)	2

The parameters of meander shape, for example *w1, w2. V2* shown as in the figure will affect the antenna performance parameter. In order to find the best antenna solution, different values of meander ground conditions are simulated and studied. Here, antenna ground conditions and also the substrate material are varied and compared for better results. Frequency range of c-band is chosen for the design of E-shaped MLA design. The C band (4 to 8 GHz) is used for many satellite communications transmissions, some Wi-Fi devices, some cordless telephones as well as some surveillance andweatherradar systems. Communication satellite operates mostly at C band (4-8 Ghz) & Ku Band (12–18 Ghz). For transmission and reception, the band of frequencies used are from 3.7 to 4.2 GHz for their downlinks, and the band of frequencies from 5.925 to 6.425 GHz for their uplinks. In this work, the wireless application is given a major focus.

RESULTS AND DISCUSSION

Antenna design from the above models of Fig. 1. are constructed and simulated in Ansoft HFSS 3D EM simulator for the evaluation. Different simulation results obtained for varying ground is shown in table. 2, 3 and Fig. 4 for the return loss and VSWR of the proposed antennas as a function of frequency. Table. 2, results for the partial ground condition using dielectric materials such as FR-4 Epoxy and RT-Duroid is tabulated for partial ground condition.

Table. 2, Results for the partial ground condition

PARAMETERS	FR-4 EPOXY	RT-DUROID
Resonant Frequency	3.7 GHz	7.435 GHz
Return Loss	-20.63dB	-15.2473 dB
Efficiency	0.831	1.09
VSWR	1.20	16.47
Gain	1.0	2.4679 dB
Directivity	1.21 dB	2.261 dB
Bandwidth	20MHz	32MHz

FR-4 Epoxy substrate works in multi-band condition. Values are tabulated in Fig. 3. As a result of simulation FR-4 Epoxy material and RT-Duroid gives a good return loss and stands good in Bandwidth under partial ground condition.Results for the full ground condition using dielectric materials such as FR-4 Epoxy and RT-Duroid is tabulated shown in Table. 3. The full ground condition dimension is 20mm x 11mm.

TABLE. 3. Values of FR-4 Epoxy under multiband condition

Resonant frequency	Return loss	Bandwidth
3.7GHz	-20.6370	20
4.92GHz	-15.3613	30
5.77GHz	-17.8941	19
6.895GHz	-13.9452	14

Table. 4. Values of RT Duroid under multiband condition

Resonant frequency	Return loss	Bandwidth
4.1950GHz	-17.2116	20
4.87GHz	-11.3049	30
7.4350GHz	-15.2473	19

Table.5. Results for the full ground condition

PARAMETERS	FR-4 EPOXY
Resonant Frequency	7.84 GHz
Return Loss	-14.10 dB
Efficiency	0.64
VSWR	1.49
Gain	2.62 dB
Directivity	4.09 dB
Bandwidth	24 MHz

As a result of simulation FR-4 Epoxy material gives a good Bandwidth and good return loss. In the other hand, RT Duroid material does not give good result in full ground condition. It has a return loss greater than -10 dB. Not good bandwidth in result.

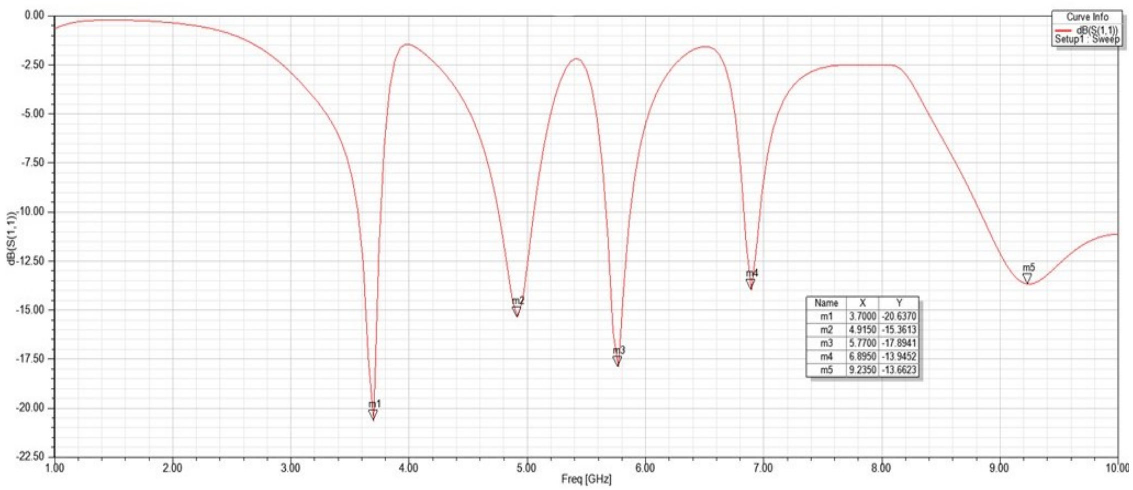

Fig. 4. Return loss of the FR-4 Epoxy partial ground condition

Here, when FR-4 Epoxy material is used as substrate, the resulting frequency operates in multiband frequency condition.

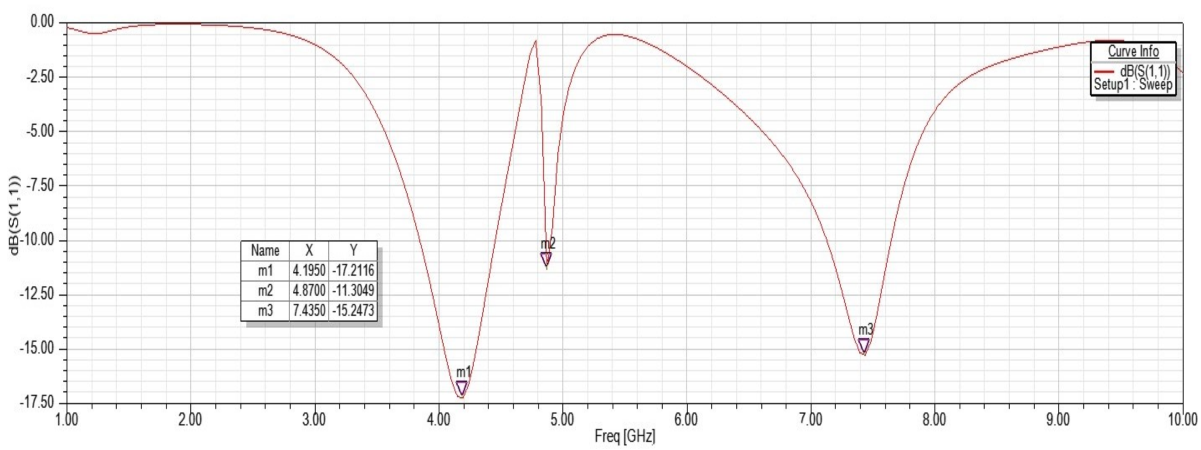

Fig. 5. Return loss of the RT-Duroid partial ground condition

Here, when RT-Duroid material is used as substrate, the resulting frequency operates in multiband frequency condition.

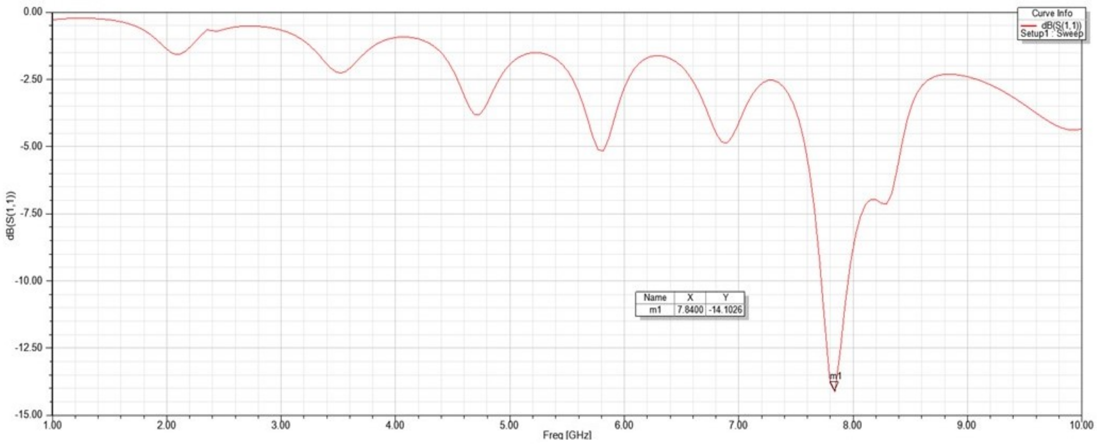

Fig. 6. Return loss of the FR-4 Epoxy full ground condition

The resulting frequency operates in single band frequency condition for FR-4 Epoxy material in full ground case.

CONCLUSION

A novel design analysis of meander line antenna (MLA) is proposed in this paper. The MLA is successfully capable to function at multiband and wide bandwidth simulated of 32MHz for RT-Duroid and
20MHz for FR-4 Epoxy material as substrate of thickness 1.6mm. This work shows that smaller variation in the model can have large influence in the result. Proposed antenna has potential to be implemented for c-Band applications such as Satellite communication.

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